



## Worksheet 2 Simplifying Boolean expressions

### Task 1

1. X, Y and Z are Boolean variables which can be either TRUE or FALSE, represented by 1 and 0.

Complete the following “rules” of Boolean algebra:

#### General rules

1.  $X \wedge 0 =$

2.  $X \wedge 1 =$

3.  $X \wedge X =$

4.  $X \neg X =$

5.  $X \vee 0 =$

6.  $X \vee 1 =$

7.  $X \vee X =$

8.  $X \vee \neg X =$

9.  $\neg X =$

#### Commutative rule

10.  $X \wedge Y =$

11.  $X \vee Y =$

#### Associative rule

12.  $X \wedge (Y \wedge Z) =$

13.  $X \vee (Y \vee Z) =$

#### Distributive rule

14.  $X \wedge (Y \vee Z) =$

15.  $(X \vee Y) \wedge (W \vee Z) =$

#### Absorption rules

16.  $X \vee (X \wedge Y) =$

17.  $X \wedge (X \vee Y) =$



2. Write down de Morgan's first and second laws:
3. Use de Morgan's laws and the rules of Boolean algebra to simplify the following expressions, stating which rule you use at each step.

(a)  $X \wedge Y \vee X \wedge (Y \vee Z)$

(b)  $(X \vee Y) \wedge (\neg X \vee \neg Y)$

(c)  $X(XY)$

(d)  $(X \vee Y)(X \vee Z)$

4. Complete the truth table to show that  $A \wedge A B = A B$

<b>A</b>	<b>B</b>	<b><math>\neg A</math></b>	<b><math>\neg A \wedge B</math></b>	<b><math>A \vee \neg A \wedge B</math></b>	<b><math>A \vee B</math></b>
0	0				
0	1				
1	0				
1	1				

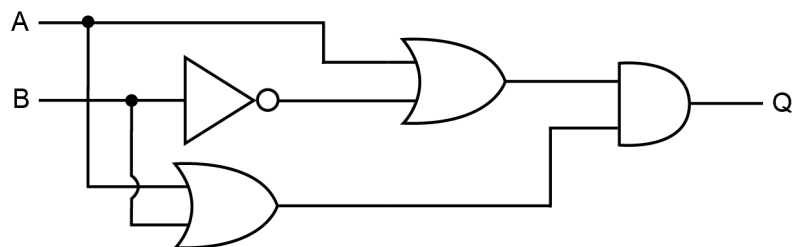


## Task 2

5. Simplify the expression  $A \cdot B + A \cdot (B \cdot C)$

Draw a logic circuit representing the simplified expression, using only 2 gates.

6. (a) Write the Boolean expression representing the logic circuit below.



- (b) Complete the truth table to prove the Absorption rules:

$$X \vee (X \wedge Y) = X$$

$$X \wedge (X \vee Y) = X$$

X	Y	$(X \wedge Y)$	$(X \vee Y)$	$X \vee (X \wedge Y)$	$X \wedge (X \vee Y)$
0	0				
0	1				
1	0				
1	1				



(c) Simplify the expression.

$$A \vee A \vee A \vee B \vee A \vee \neg B \vee B \vee \neg B \quad (\text{Tip: Use the Absorption rule})$$

(d) With reference to the above example, explain why de Morgan's Laws and the rules of Boolean algebra have a huge commercial significance in the manufacture of computers.